Mark Scheme (Results)

October 2024

Pearson Edexcel International Advanced Subsidiary Level in Chemistry (WCH11)
Paper 01 Structure, Bonding and Introduction to Organic Chemistry

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A

Question Number	Answer	Mark
1	**The only correct answer is A** ($C_{10}H_8$) ***B*** *is incorrect because there are only 8 hydrogens, one on each of the carbons which are not linking the two rings* ***C*** *is incorrect because there are only 10 carbons and 8 hydrogen atoms* ***D*** *is incorrect because there are only 10 carbons and 8 hydrogen atoms*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is D** (MgN_6) ***A*** *is incorrect because the azide ion is -1, so two azide ions will match the 2+ charge on magnesium* ***B*** *is incorrect because each azide ion has 3 nitrogen atoms in, not 1* ***C*** *is incorrect because the magnesium ion is 2+ so another azide ion is needed*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is C** (2.408×10^{22}) ***A*** *is incorrect because this is the number of* H_2SO_4 *molecules in 0.0100 mol* ***B*** *is incorrect because this is the number of oxygen molecules required to give this many oxygen atoms* ***D*** *is incorrect because this is the number of atoms in 0.0100 mol of* H_2SO_4	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is A** (argon) ***B*** *is incorrect because this would have a mass of 176 mg* ***C*** *is incorrect because this would have a mass of 16 mg* ***D*** *is incorrect because neon is monatomic not diatomic*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is C** (x = 2, y = 7, z = 4) ***A*** *is incorrect because x must be 2 to match the 4 P in* P_4O_{10} ***B*** *is incorrect because z must be 4 to give 8 H to match the H in* $2P_2H_4$ ***D*** *is incorrect because x must be 2 to match the 4 P in* P_4O_{10}	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is C** (between 20 g and 40 g) ***A*** *is incorrect because the atomic mass of silver is greater than that of copper so more than 20 g will be formed* ***B*** *is incorrect because the atomic mass of silver is greater than that of copper so more than 20 g will be formed* ***D*** *is incorrect because the atomic mass of silver is less than twice that of copper so less than 40 g will be formed*	**(1)**

Question Number	Answer	Mark
7	**The only correct answer is C** (3.00 dm^3) ***A*** *is incorrect because this is the volume if oxygen were the only gas produced* ***B*** *is incorrect because this is the volume if oxygen were the only gas and 1 mol of calcium nitrate gave 1 mol of oxygen* ***D*** *is incorrect because this is the volume of gas if 1 mol of calcium nitrate gave 5 mol of gas*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is C** (51%) ***A*** *is incorrect because this is the molecular mass of ethanol ÷ total mass of products × 100* ***B*** *is incorrect because this is the percentage by mass of carbon dioxide* ***D*** *is incorrect because this is the ratio of the mass of carbon dioxide to the mass of ethanol × 100*	**(1)**

Question Number	Answer	Mark
9(a)	**The only correct answer is B** (1.6734×10^{-24}) ***A*** *is incorrect because there is one proton and one electron in* ^1H. *This is the mass of a proton.* ***C*** *is incorrect because this is the mass of one proton and one neutron, not one proton and one electron.* ***D*** *is incorrect because this is the mass of one proton, one neutron and one electron and the atom has no neutron.*	**(1)**

Question Number	Answer	Mark
9(b)	**The only correct answer is B** (electrons and protons) ***A*** *is incorrect because all charged particles are deflected so this should be protons too* ***C*** *is incorrect because neutrons are not deflected but electrons are.* ***D*** *is incorrect because neutrons are not deflected*	**(1)**

Question Number	Answer	Mark
10(a)	**The only correct answer is B** (ions of $Cl^-(g)$ and $S^{2-}(g)$ have the same ionic radius) ***A*** *is incorrect because Cl(g) atoms have the highest first ionisation energy of these elements.* ***C*** *is incorrect because the sodium atoms have the largest atomic radius.* ***D*** *is incorrect because P atoms have 3 unpaired electrons, more than any other atom.*	**(1)**

Question Number	Answer	Mark
10(b)	**The only correct answer is D** (S) ***A*** *is incorrect because Al is not held together by intermolecular forces as it is a metallic structure* ***B*** *is incorrect because Si is held together by covalent bonds not intermolecular forces* ***C*** *is incorrect because P is held together by intermolecular forces, but has a lower melting temperature than S*	**(1)**

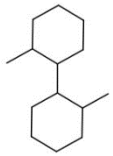
Question Number	Answer	Mark
11	**The only correct answer is A** (ionic soluble high poor) ***B*** *is incorrect because ionic compounds usually have high melting temperatures and do not conduct as a solid* ***C*** *is incorrect because metallic structures are insoluble in water and usually have high melting temperatures* ***D*** *is incorrect because metallic stuctures have good electrical conductivity*	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is C** (Sc^{3+}) ***A*** *is incorrect because this has no electrons so cannot be isoelectronic with a noble gas* ***B*** *is incorrect because this has one electron fewer than neon* ***D*** *is incorrect because though it has no s-electrons it has 10 d-electrons, 10 more than argon*	**(1)**

Question Number	Answer	Mark
13	**The only correct answer is B** (Isomer X and Isomer Z only) ***A*** *is incorrect because Isomer Y only forms two isomeric monochlorination products* ***C*** *is incorrect because Isomer Y forms two isomeric monochlorination products and Isomer X forms four* ***D*** *is incorrect because Isomer Z also forms four isomeric monochlorination products*	**(1)**

Question Number	Answer	Mark
14	**The only correct answer is A** (R—O—O—R → 2R—O•) ***B*** *is incorrect because in this step a radical and a molecule form a radical so this is a propogation step* ***C*** *is incorrect because in this step two radicals from a molecule, so this is a termination step* ***D*** *is incorrect because in this step a radical and a molecule form a radical so this is a propogation step*	**(1)**

Question Number	Answer	Mark
15(a)	**The only correct answer is B** (C_nH_{2n-2}) ***A*** *is incorrect because this would be 2 hydrogens short of the general formula* ***C*** *is incorrect because this is the general formula of alkenes or cyclic alkanes, not cyclic alkenes* ***D*** *is incorrect because this is the general formula of alkanes*	**(1)**

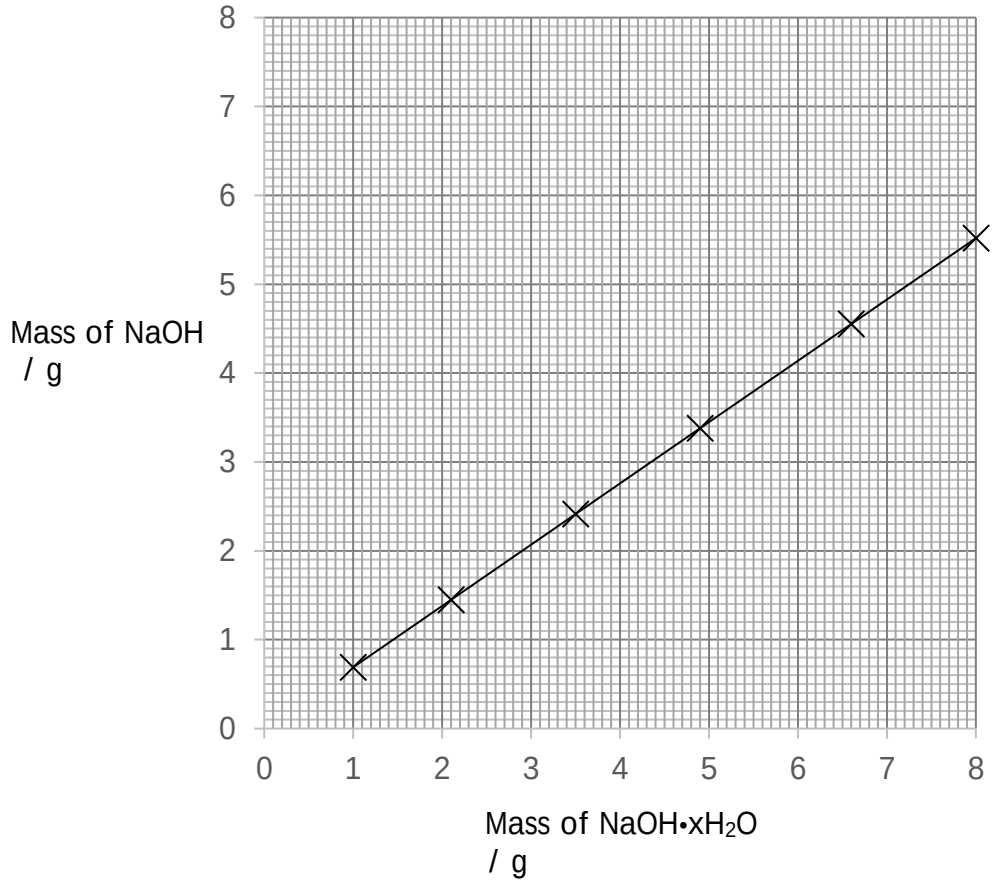
Question Number	Answer	Mark
15(b)	**The only correct answer is D** () ***A*** *is incorrect because the two new bonds on each hexagon must be at either end of the double bond in cyclohexene* ***B*** *is incorrect because the two new bonds on each hexagon must be at either end of the double bond in cyclohexene* ***C*** *is incorrect because there should be two new single bonds on each hexagon*	**(1)**

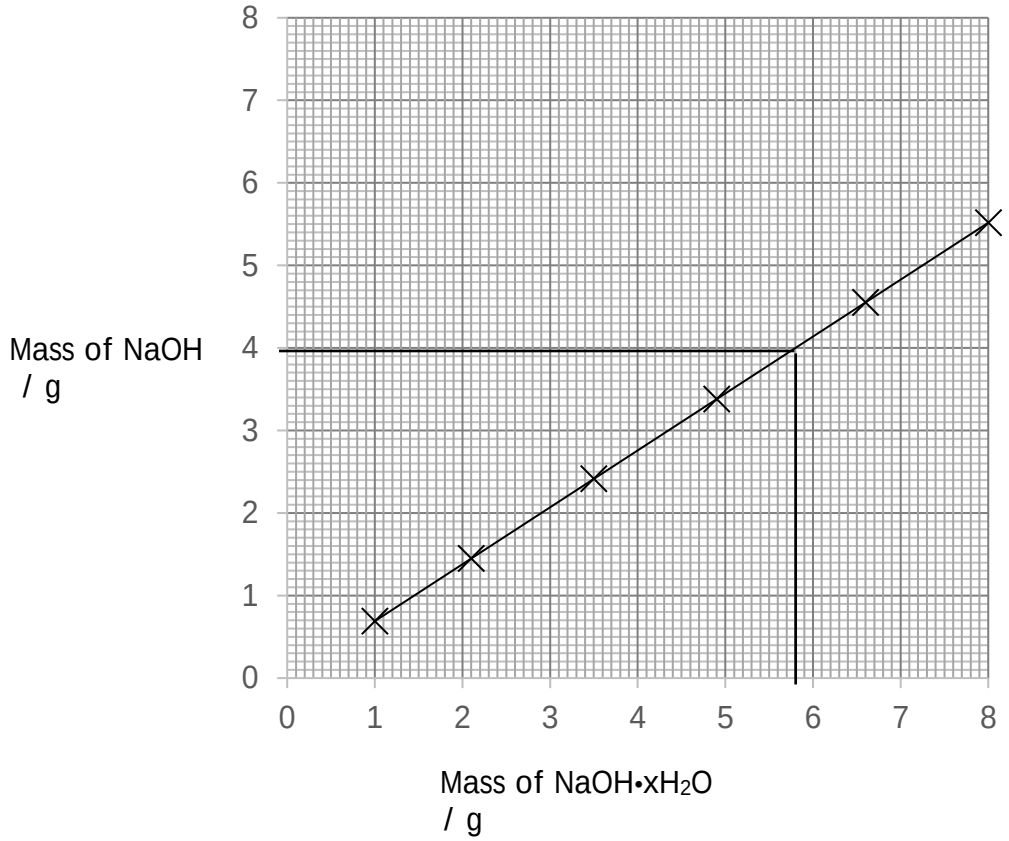
Question Number	Answer	Mark
15(c)	**The only correct answer is D** (12.2 g) ***A*** *is incorrect because this is the value if the molecular masses are reversed and the yield inverted.* ***B*** *is incorrect because this is the value if the molecular masses are reversed and the yield is 100%* ***C*** *is incorrect because this is the mass needed if the yield is 100%*	**(1)**

Question Number	Answer	Mark
16	**The only correct answer is A** (*E* **|** *E*) ***B*** *is incorrect because double bond 2 is an E configuration* ***C*** *is incorrect because double bond 1 is an E configuration* ***D*** *is incorrect because both double bonds are E configuration*	**(1)**

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Answer	Additional Guidance	Mark
17(a)(i)	• six points plotted correctly within a square **(1)** • axes labelled including units **(1)** • straight line passing through all points **(1)**	Example of graph  Allow line of best fit going through 0,0 Allow axes reversed. Allow "(g)" instead of "/ g" for units	**(3)**

Question Number	Answer	Additional Guidance	Mark
17(a)(ii)	An answer that makes reference to the following point: • mass of $NaOH \cdot xH_2O$ read from the graph (using a line on the graph)	 Expected value is 5.8 g (± 0.1) but value should be from the graph. Allow TE on the line of best fit Allow correct reading of value from graph with axes reversed.	**(1)**

Question Number	Answer		Additional Guidance	Mark
17(a)(iii)	EITHER		<u>Example of calculation</u>	**(3)**
	• calculation of moles of NaOH in 4 g	**(1)**	4.0 ÷ 40 = 0.1 (mol)	
	• calculation of molecular mass of $NaOH{\cdot}xH_2O$	**(1)**	5.8 ÷ 0.1 = 58 ($g\ mol^{-1}$)	
	• calculation of x	**(1)**	58 − 40 = 18 Therefore x = 1	
			Allow calculation from any other point on the graph max (2)	
	OR		Allow TE on (a)(ii)	
	• a subtraction either Mr or mass	**(1)**		
	• two mole calculations	**(1)**		
	• mole ratio and final answer must be a whole number	**(1)**	Correct answer with no working 1 mark only	

Question Number	Answer	Additional Guidance	Mark
17(b)	• calculation of molar mass $NaOH•7H_2O$ • calculation of mass of 0.150 mol of $NaOH•7H_2O$ • calculation of mass needed for 250 cm^3 OR • calculation of moles in 250cm^3 • calculation of molar mass • calculation of mass	<u>Example of calculation</u> $23 + 16 + 1 + (7 \times 18) = 166$ ($g\ mol^{-1}$) $0.150 \times 166 = 24.9$ (g) $24.9 \div 4 = 6.225/6.23$ (g) Ignore SF except 1 SF Correct answer without working scores 2 0.15 x 0.250 = 0.0375 $23 + 16 + 1 + (7 \times 18) = 166$ ($g\ mol^{-1}$) 0.0375 x 166 = 6.225 / 6.23	**(2)**

(Total for Question 17 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
18(a)	An answer that makes reference to the following points: • (Molecular formula) C_8H_{18} **(1)** • (Empirical formula) C_4H_9 **(1)** • (IUPAC name) 2,2,4-trimethylpentane **(1)**	Ignore incorrect punctuation and a gap between trimethyl and pentane If MP1 and 2 are not scored allow a molecular formula which is a multiple of the empirical formula given and which has 8 carbons for (1).	**(3)**

Question Number	Answer	Additional Guidance	Mark
18(b)(i)	An answer that makes reference to the following point: • fractional distillation / fractionation	Do not award simple distillation or just distillation	**(1)**

Question Number	Answer	Additional Guidance	Mark
18(b)(ii)	An answer that makes reference to the following points: • isooctane boils first **(1)** • isooctane condenses (in the condenser) **and** is collected **(1)**	Allow isooctane evaporates / vaporises before octane or first or faster Allow isooctane evaporates / vaporises below 125ºC Allow octane remains in the flask / container	**(2)**

Question Number	Answer	Additional Guidance	Mark
18(c)(i)	An answer that makes reference to the following point: • correct balanced equation	<u>Example of equation:</u> $C_8H_{18} + 12½O_2 \rightarrow 8CO_2 + 9H_2O$ Allow multiples Do not penalise incorrect formula of octane (as this may have been penalised in (a). Ignore state symbols even if incorrect	**(1)**

Question Number	Answer	Additional Guidance	Mark
18(c)(ii)	An answer that makes reference to the following points: • carbon monoxide is formed by incomplete combustion **(1)** • due to insufficient oxygen / too much hydrocarbon **(1)** • nitrogen monoxide is formed by the reaction of nitrogen and oxygen (from the air) **(1)** • due to high temperature (in the engine) / high pressure (in the engine) / a spark **(1)**	**Do not award unbalanced equations** $C_8H_{18} + 8½O_2 \rightarrow 8CO + 9H_2O$ Allow any **balanced** equation for an alkane or carbon reacting with oxygen to form carbon monoxide, water and any other appropriate products such as CO_2. If an equation is give there is no need to mention incomplete combustion Ignore $C_8H_{18} + 17[O] \rightarrow 8CO + 9H_2O$ Allow $N_2 + O_2 \rightarrow 2NO$ Do not award if nitrogen from / in the fuel	**(4)**

Question Number	Answer	Additional Guidance	Mark
18(c)(iii)	An answer that makes reference to the following point: • nitrogen dioxide / NO_2 / sulfur dioxide / SO_2 / sulfur trioxide / SO_3 / carbon (particulates) / soot / unburnt hydrocarbons	Allow dinitrogen tetroxide / N_2O_4 Allow oxides of sulfur / SOx Allow oxides of nitrogen / NOx Allow PM10 or PM2.5 Allow formula for a feasible hydrocarbon Ignore water Do not award CO_3, SO, NO_3,	**(1)**

Question Number	Answer	Additional Guidance	Mark
18(d)(i)	An answer that makes reference to the following point: • free radical substitution		**(1)**

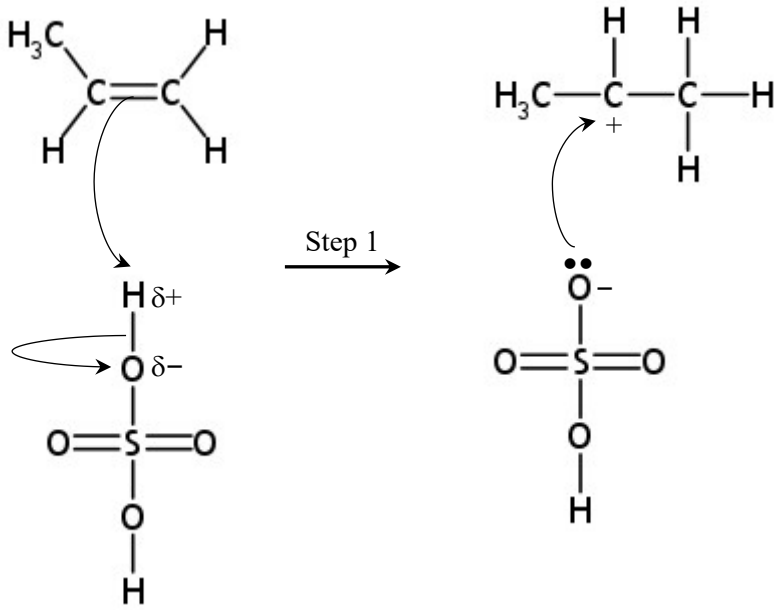
Question Number	Answer	Additional Guidance	Mark
18(d)(ii)	An answer that makes reference to the following point: • uv (light) / ultra-violet (light) / uv radiation / ultra-violet radiation	Allow sunlight Ignore just light	**(1)**

Question Number	Answer	Additional Guidance	Mark
18(d)(iii)	• calculation of percentage of **chlorine** (1) • calculation of number of moles of each element (1) • calculation of ratio and molecular formula (1)	<u>Example of calculation:</u> 100 – 44.1 – 6.90 = 49.0 C 44.1 ÷ 12 = 3.675 H 6.9 ÷ 1 = 6.9 Cl 49.0 ÷ 35.5 = 1.38 C:H:Cl = 2.66 : 5 : 1 = 8 : 15 : 3 Therefore $C_8H_{15}Cl_3$ Allow TE on each step, but final answer must have 8 carbons to score MP3 Ignore SF	**(3)**

(Total for Question 18 = 17 marks)

Question Number	Answer	Additional Guidance	Mark
19(a)(i)	An answer that makes reference to the following point: • electrophilic addition	Do not award substitution	(1)

Question Number	Answer	Additional Guidance	Mark
19(a)(ii)	An explanation that makes reference to the following points: • (because) the formation of 2-chloropropane / the major product proceeds via a secondary **carbocation** **(1)** • (but) the reaction / the formation of 1-chloropropane / the formation of the minor product proceeds via a primary **carbocation** **(1)** • (and) secondary carbocations are more stable than primary carbocations **(1)**	Do not award 2-chloropropane is a secondary carbocation Do not award 1-chloropropane is a primary carbocation Allow TE on incorrect type of carbocations used in M1 and M2 but must be in the correct order of stability (3º more stable than 2º more stable than 1º)	(3)

Question Number	Answer	Additional Guidance	Mark
19(b)	All 9 points scores (4) 7 or 8 points scores (3) 5 or 6 points scores (2) 3 or 4 points scores (1) • dipole on O–H bond • arrow from double bond to correct H or just in front of H • arrow from O–H bond to O • structure of intermediate carbocation ignoring any charge • positive charge on intermediate carbocation • structure of intermediate anion • single negative charge on intermediate anion • lone pair of electrons on relevant O • arrow from lone pair of electrons to correct carbon	Example of diagram:  Allow charge on the anion anywhere on the ion including outside a bracket	**(4)**

(Total for Question 19 = 8 marks)

Question Number	Answer	Additional Guidance	Mark
20(a)(i)	An explanation that makes reference to the following points: 4 points award 2 marks 2 or 3 points award 1 mark • first ionisation increases (across the period) • due to increased nuclear attraction / because there is an increasing attraction between the electrons and the nucleus • as electrons are added to / removed from the same shell of electrons • the number of protons / positive charge increases	 Allow have similar shielding for same shell Allow nuclear charge increases	**(2)**

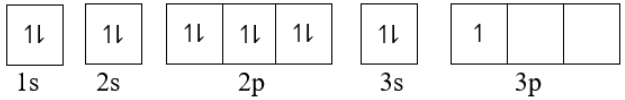
Question Number	Answer	Additional Guidance	Mark
20(a)(ii)	An explanation that makes reference to the following points: • boron **(1)** • the electron (being removed) is from the **2**p subshell (not the 2s as for Li and Be) **(1)** • which is further from the nucleus than the 2s electrons so is more **shielded** **(1)**	 Allow abbreviated electron configuration for boron ($2s^2\ 2p^1$) Accept just is more **shielded** Ignore just is further from the nucleus	**(3)**

Question Number	Answer	Additional Guidance	Mark
20(b)	An answer that makes reference to the following point: • sulfur / S		**(1)**

Question Number	Answer	Additional Guidance	Mark
20(c)(i)	• a cross on the line for boron between 2000 K and 3500 K (2573 K) **(1)** • a cross on the line for nitrogen below the cross for lithium (63 K) **(1)**	Allow any clear indication of the position of the melting temperature Allow the cross not perfectly on the line for each element	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(c)(ii)	An explanation that makes reference to the following points: • Graphite / diamond / carbon are lattices / giant structure with **covalent** bonds (between the atoms) **(1)** • Held together by **strong** covalent bonds **(1)** • (which) require a lot of energy to break **(1)**	Do not award mention of ionic bonding / metallic bonding scores 0 overall Penalise use of molecules or intermolecular once only Allow sigma bonds for covalent bonds Allow (in diamond) each carbon is bonded to four other carbon atoms or (in graphite) each carbon is bonded to three other carbon atoms in layers Ignore macromolecular Ignore giant covalent bond	**(3)**

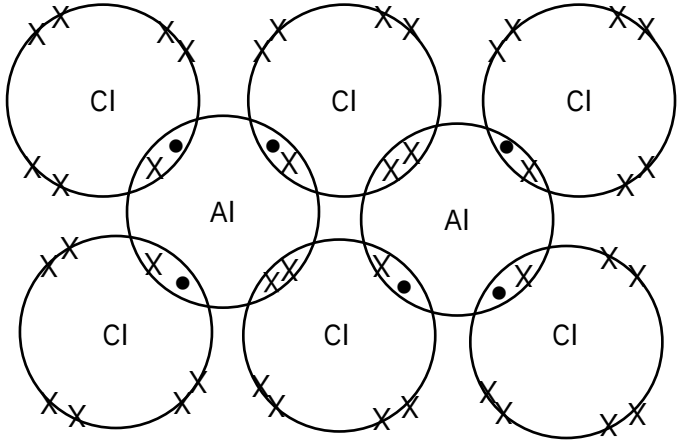
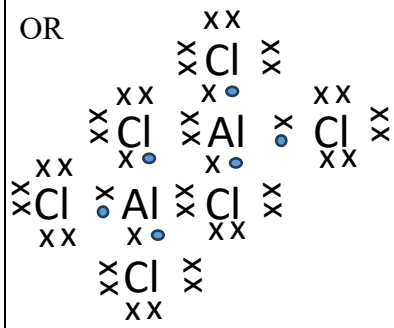
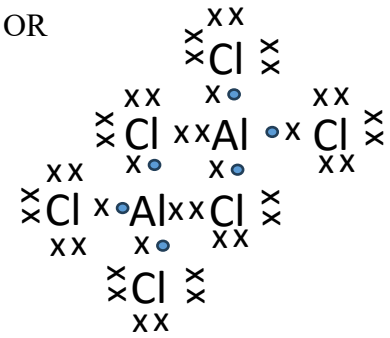
(Total for Question 20 = 11 marks)

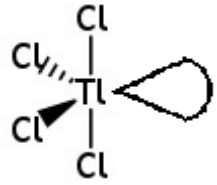
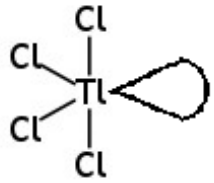
Question Number	Answer	Additional Guidance	Mark
21(a)(i)	An answer that makes reference to the following point: • $1s^2 2s^2 2p^6 3s^2 3p^1$	Allow  Allow double headed arrows Ignore $[Ne]3s^2\ 3p^1$ Ignore 2,8,3	(1)

Question Number	Answer	Additional Guidance	Mark
21(a)(ii)	An answer that makes reference to the following points: • they have the same number of / 3 outershell electrons **(1)** • they have different numbers of shells of electrons / boron has two shells, aluminium 3 shells and thallium 6 shells **(1)**	Ignore reference to d-electrons in thallium Allow all (n) $s^2\ p^1$ Allow electron configurations Allow number of shells increase down the group Ignore different number of sub-shells	(2)

Question Number	Answer	Additional Guidance	Mark
21(a)(iii)	An answer that makes reference to the following points: • all three will be the same shape (because they have the same number of outer shell electrons to form bonds with chlorine) **(1)** • trigonal planar **(1)** • because there are three bonding pairs of electrons and no lone pairs of electrons which are at maximum separation / minimum repulsion **(1)**	**M2 and M3 may be scored for any one molecule identified as trigonal planar** Allow any of the three stated as trigonal planar Allow triangular planar / planar triangle Allow this explanation for any one of the three. No TE from incorrect shape	**(3)**

Question Number	Answer	Additional Guidance	Mark
21(b)(i)	• calculation of moles of aluminium chloride **(1)** • rearrangement of $pV = nRT$ **(1)** • calculation of number of moles **(1)** **and** number of moles are the same (so consistent with Al_2Cl_6) OR • Calculation of M_r or moles **(1)** • Use of PV=nRT correctly rearranged for n or V **(1)** • Evaluated answer **and** comparison with Al_2Cl_6 data **(1)**	<u>Example of calculation:</u> $5.00 \div 267 = 0.018727 / 1.8727 \times 10^{-2}$ (mol) $= 0.0187 / 1.87 \times 10^{-2} / 0.019 / 1.9 \times 10^{-2}$ $n = pV \div RT$. May be seen in the expression in M3 $(0.000700 \times 101000) \div (8.31 \times 455) = 0.018699 / 1.8699 \times 10^{-2}$ $= 0.0187 / 1.87 \times 10^{-2} / 0.019 / 1.9 \times 10^{-2}$ Allow alternative method Ignore SF except 1 SF $V = nRT/p$ Ignore SF except 1 SF	**(3)**

Question Number	Answer	Additional Guidance	Mark
21(b)(ii)	An answer that makes reference to the following point: • 3 covalent bonds, one dot, one cross, between each Al and 3 Cl atoms **(1)** • 2 dative covalent bonds with two crosses between one Al and one Cl **(1)** • 3 lone pairs of electrons on the terminal Cl atoms, two pairs on the bridging Cl atoms **(1)**	Example of diagram  OR  OR  If all dots or all crosses are used allow M2 and M3 for the correct numbers of electrons marked as dots or crosses. No TE anywhere	**(3)**

Question Number	Answer		Additional Guidance	Mark
21(c)	• a diagram of the $TlCl_4^{3-}$ ion including one lone pair of electrons on Tl	**(1)**	Examples of diagrams Allow diagrams without dots and wedges Ignore absence of charge (as in the diagrams below) Ignore estimated bond angles, even if incorrect for M1.  	**(3)**
	• an estimated bond angle of ≤ 120º shown between the two equatorial Cls	**(1)**		
	• at least one estimated bond angle of ≤ 90º shown between two Cl (an axial and an equatorial Cl)	**(1)**	Ignore 180º No TE on M2 or M3 for incorrect shape	

(Total for Question 21 = 15 marks)

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